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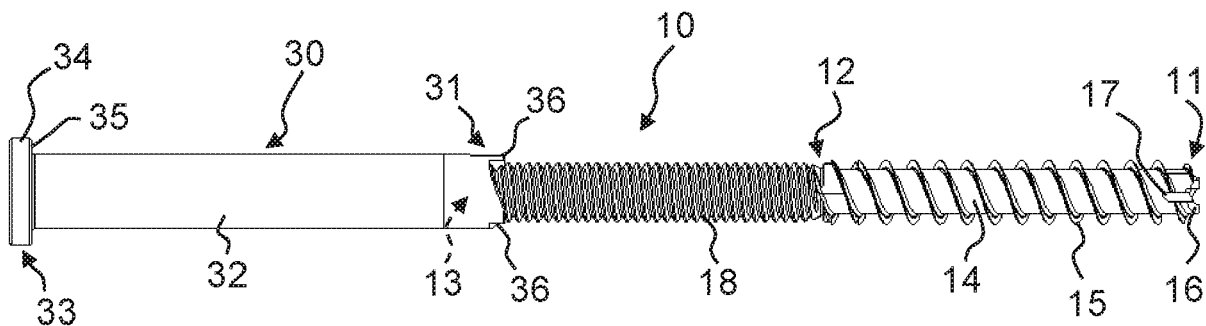
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(54) **IMPLANTABLE COMPRESSION SCREWS**

(57) A compression screw for applying compression at a bone joint. The compression screw includes an axial screw body extending from a distal end to a proximal end with the distal end including a series of bone engaging threads configured to be self-drilling and self-tapping and the proximal end including a head which defines a radially extending shoulder. At least one proximal rotary cutting

structure is defined proximally of the bone engaging threads. The at least one proximal rotary cutting structure is configured to be self-drilling such that a proximal portion of the axial screw body cuts into and advances within a bone of the bone joint as the axial screw body is advanced. A method of inserting the compression screw is also provided.



**Fig. 1**

## Description

### FIELD OF THE INVENTION

**[0001]** The present disclosure relates to implantable screws. More particularly, the disclosure relates to implantable screws configured to provide compression upon a bone into which the screw is implanted.

### BACKGROUND OF THE INVENTION

**[0002]** A broken bone must be carefully stabilized and supported until it is strong enough to handle the body's weight and movement. Until the last century, physicians relied on casts and splints to support and stabilize the bone from outside the body. The advent of sterile surgical procedures reduced the risk of infection, allowing doctors to internally set and stabilize fractured bones. During a surgical procedure to set a fracture, the bone fragments are first repositioned (reduced) into their normal alignment. They are held together with special implants, such as plates, screws, nails and wires.

**[0003]** Screws are used for internal fixation more often than any other type of implant. Although the screw is a simple device, there are different designs based on the type of fracture and how the screw will be used. Screws come in different sizes for use with bones of different sizes. Screws can be used alone to hold a fracture, as well as with plates, rods, or nails. After the bone heals, screws may be either left in place or removed.

**[0004]** In many instances, it is desired that the inserted screw provide compression at the bone joint or fracture line to reduce the incidence of nonunion (improper healing) and malunion (healing in improper position) of broken bones.

### SUMMARY OF THE INVENTION

**[0005]** To meet this and other needs, devices, systems, and methods for fixating bone are provided. In particular, bone screws are provided that apply compression to bone fragments or bone portions (for example, fixation of fractures or fusion of joints), are self-tapping and/or self-drilling, minimize or prevent screw toggle and/or back-out, remove bone build-up (for example, from cutting flutes), and the like.

**[0006]** In at least one embodiment, a compression screw is provided for applying compression at a bone joint. The compression screw includes an axial screw body extending from a distal end to a proximal end with the distal end including a series of bone engaging threads configured to be self-drilling and self-tapping and the proximal end including a head which defines a radially extending shoulder. At least one proximal rotary cutting structure is defined proximally of the bone engaging threads. The at least one proximal rotary cutting structure is configured to be self-drilling such that a proximal portion of the axial screw body cuts into and advances within

a bone of the bone joint as the axial screw body is advanced.

**[0007]** In at least one embodiment, the compression screw for applying compression at a bone joint includes a bone screw and a compression sleeve. The bone screw extends from a distal end to a proximal end with the bone screw distal end including a series of bone engaging threads configured to be self-drilling and self-tapping and the bone screw proximal end including a series of external threads. The compression sleeve has a tubular body extending from a distal end to a proximal end with the compression sleeve distal end defining a proximal rotary cutting structure and the compression sleeve proximal end including a head which defines a radially extending shoulder. The compression sleeve includes internal threads engaged with the bone screw external threads such that the compression sleeve and bone screw are threadably adjustable relative to one another. The proximal rotary cutting structure is configured to be self-drilling such that a portion of the compression sleeve cuts into and advances within a bone of the bone joint as the compression screw is advanced.

**[0008]** In at least one embodiment, a method of inserting a compression screw into a bone joint includes engaging the compression screw with a driver assembly, the driver assembly including a first driver and a second driver, the first and second drivers co-axial with one another and selectively rotatable together or independently of one another; rotating the first and second drivers simultaneously to advance the compression screw into the bone joint until the compression screw is at a first desired location; and rotating the first driver while maintaining the second driver stationary whereby at least a portion of the compression screw is further advanced into the bone joint such that a compressive force is applied to the bone joint.

**[0009]** According to a further aspect of the invention, it is provided a compression screw for applying compression at a bone joint, the compression screw comprising: a bone screw extending from a distal end to a proximal end, the bone screw distal end including a series of bone engaging threads configured to be self-drilling and self-tapping, and the bone screw proximal end including a series of external threads; a compression sleeve having a tubular body extending from a distal end to a proximal end, the compression sleeve distal end defining a proximal rotary cutting structure and the compression sleeve proximal end including a head which defines a radially extending shoulder, the compression sleeve including internal threads engaged with the bone screw external threads such that the compression sleeve and bone screw are threadably adjustable relative to one another; wherein the proximal rotary cutting structure is configured to be self-drilling such that a portion of the compression sleeve cuts into and advances within a bone of the bone joint as the compression screw is advanced.

**[0010]** In a version, the bone screw proximal end and the compression sleeve proximal end each define a distinct driver feature.

**[0011]** In a further version, the head includes external threads such that the head is self-countersinking, the external threads on the head defining a second proximal rotary cutting structure.

**[0012]** In another version, the at least one proximal rotary cutting structures is defined by a plurality of cutting flutes defined at the compression sleeve distal end.

**[0013]** Advantageously, each cutting flute has a slot extending therefrom, each slot recessed into the tubular body.

**[0014]** Advantageously, the cutting flutes have a trajectory and each slot has a trajectory substantially equal to the trajectory of the cutting flutes.

**[0015]** In a version, the cutting flutes have a trajectory and each slot has a trajectory greater than the trajectory of the cutting flutes.

**[0016]** In a further version each slot has a trajectory substantially parallel to an axis of the compression sleeve.

**[0017]** In another version, each slot has a cross-sectional configuration selected from semi-circular, semi-oval, v-shaped, square and rectangular.

**[0018]** According to another aspect of the invention, it is provided a method of inserting a compression screw into a bone joint, the method comprising: engaging the compression screw with a driver assembly, the driver assembly including a first driver and a second driver, the first and second drivers co-axial with one another and selectively rotatable together or independently of one another; rotating the first and second drivers simultaneously to advance the compression screw into the bone joint until the compression screw is at a first desired location; and rotating the first driver while maintaining the second driver stationary whereby at least a portion of the compression screw is further advanced into the bone joint such that a compressive force is applied to the bone joint.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0019]** The accompanying drawings, which are incorporated herein and constitute part of this specification, illustrate the presently preferred embodiments of the invention, and, together with the general description given above and the detailed description given below, serve to explain the features of the invention. In the drawings:

Fig. 1 is a plan view of a compression screw according to an embodiment of the invention.

Fig. 2 is an end view of the compression screw of Fig. 1.

Fig. 3 is a perspective view of a compression sleeve in accordance with another exemplary embodiment. Fig. 4 is an expanded view of the cutting end of the compression sleeve of Fig. 3.

Fig. 5 is an expanded view of the cutting end of a compression sleeve in accordance with another exemplary embodiment.

Fig. 6 is an expanded view of the cutting end of a

compression sleeve in accordance with yet another exemplary embodiment.

Fig. 7 is a plan view of an exemplary driver assembly configured for implantation of the compression screw of Fig. 1.

Fig. 8 is a cross-sectional view of the driver assembly of Fig. 7 engaged with the compression screw of Fig. 1.

Fig. 9 is a plan view of a compression screw according to another embodiment of the invention.

Fig. 10 is a plan view similar to Fig. 9 with the compression sleeve shown transparently.

Fig. 11 is a plan view of an exemplary driver assembly configured for implantation of the compression screw of Fig. 9.

Fig. 12 is a cross-sectional view of the driver assembly of Fig. 11.

Fig. 13 is a cross-sectional view of the driver assembly of Fig. 11 engaged with the compression screw of Fig. 9.

Fig. 14 is a plan view of a compression screw according to another embodiment of the invention.

Fig. 15 is an expanded perspective view of the tip of the compression screw of Fig. 14.

Fig. 16 is an expanded perspective view of the head of the compression screw of Fig. 14.

Fig. 17 is a plan view of an exemplary driver assembly engaging the compression screw of Fig. 14.

Fig. 18 is a cross-sectional view of the driver assembly of Fig. 17 engaged with the compression screw of Fig. 14.

#### DETAILED DESCRIPTION OF THE INVENTION

**[0020]** In the drawings, like numerals indicate like elements throughout. Certain terminology is used herein for convenience only and is not to be taken as a limitation on the present invention. The following describes preferred embodiments of the present invention. However, it should be understood, based on this disclosure, that the invention is not limited by the preferred embodiments described herein.

**[0021]** Devices, systems, and methods for fixing bone are provided. In particular, bone screws are provided that may apply compression to bone fragments or bone portions. This may be particularly effective, for example, in trauma applications for fixation of bone fractures and/or fusion of joints. The disclosed devices and methods may be used for repairing bones including, but not limited to, the femur, tibia, fibula, humerus, ulna, radius, metatarsals, phalanx, phalanges, ribs, spine, vertebrae, clavicle, and other bones. Any of the features described herein may be applied to standalone screws or screws that additionally include a compression sleeve.

**[0022]** Referring to Figs. 1-2 and 8, a compression screw 10 in accordance with an embodiment will be described. The compression screw 10 generally comprises a bone screw 12 and a compression sleeve 30. The bone

screw 12 and the compression sleeve 30 may be constructed from any biocompatible material including, but not limited to, stainless steel alloys, titanium, titanium based alloys, or polymeric materials.

**[0023]** The bone screw 12 includes a shaft 14 extending from a distal end 11 to a proximal end 13. Referring to Figs. 2 and 8, in the illustrated embodiment, a cannula 20 extends from the distal end 11 to the proximal end 13 such that a guide wire may be used for positioning the compression screw 10. A drive feature 22 is defined in the proximal end 13 of the shaft 14 and is configured and dimensioned to be any shape that corresponds with the end of the driving instrument designed to engage the bone screw 12. As an example, in the illustrated embodiment, the drive feature 22 has a hexalobular configuration.

**[0024]** A series of bone engaging threads 15 extend radially from the shaft 14 at the distal end 11 and a series of sleeve engaging threads 18 extend radially from the shaft 14 at the proximal end 13. In the preferred embodiment, the bone engaging threads 15 are dual lead thread type and the sleeve engaging threads 18 are a standard machine thread. However, any type of thread for either thread series 15, 18 may be used to facilitate the function of the compression screw 10. The bone screw 12 preferably also includes at least one cutting flute 16 configured to cut into the bone as the bone screw 12 is rotated, defining a self-drilling and self-tapping tip. In a preferred embodiment, a slot 17 is associated with each cutting flute 16 to clear any chips, dust, or debris generated when the compression screw 10 is implanted into bone tissue.

**[0025]** The compression sleeve 30 includes a tubular body 32 extending from a distal end 31 to a proximal end 31 with an internal passage 40 therethrough. The compression sleeve 30 includes a series of internal threads 39 (see Fig. 8) configured to engage the sleeve engaging threads 18 of the bone screw 12 such that the bone screw 12 and the compression sleeve 30 are threadably adjustable to one another. The proximal end 33 of the compression sleeve 30 defines a radially extending head 34 which defines a shoulder 35 between the tubular body 32 and the head 34. A drive feature 42 is defined in the head 34 of the compression sleeve 30 and is configured and dimensioned to be any shape that corresponds with the end of the driving instrument designed to engage the compression sleeve 30. As an example, in the illustrated embodiment, the drive feature 42 has a hexalobular configuration.

**[0026]** As will be described in more detail hereinafter, during insertion of the implant, both drive features 22, 42 are engaged such that the compression screw 10 maintains its full length. After the tip of the bone screw 12 is at the desired depth, only the drive feature 42 in the compression sleeve 30 is actuated. Since the two components are connected via threads, actuation of only the compression sleeve 30 will act to move the compression sleeve 30 distally toward the tip of the bone screw 12, which shortens the length of the compression screw 10

and compresses the bone when the shoulder 35 of the compression sleeve 30 is on the near cortex.

**[0027]** To facilitate such shortening of the compression screw 10, the distal end 31 of the compression sleeve 30 is provided with one or more cutting flutes 36 configured to cut into the bone as the compression sleeve 30 is rotated. The cutting flutes 36 simplify the procedure by removing material without the necessity of drilling to the outer diameter of the compression sleeve tubular body 32. This also allows the compression screw 10 to be adjusted to any length without the need to predrill to a desired depth to accommodate the compression sleeve 30. In the present embodiment, the cutting flutes 36 define a proximal rotary cutting structure.

**[0028]** In the alternative embodiment of the compression sleeve 30' illustrated in Figs. 3 and 4, a slot 38 is associated with each cutting flute 36, with each slot recessed into the surface of the tubular body 32 and configured to guide the aforementioned cut bone into the slots 38. The mechanism of action for this technology relies on first the cutting flutes 36 to remove material from the substrate that it is being inserted into. This material then follows through the path of the slots 38 by one of two mechanisms: (1) path of least resistance (the material has nowhere else to go) or (2) the trajectory of the slots 38 roughly follows the pitch of the cutting flutes 36 as it is advanced into the bone, and thus the cutaway material stays close to its original position as the screw advances axially via the screw's helix.

**[0029]** The slots 38 serve two functions: (1) the cut bone that follows the slots 38 acts to enhance the fit between the native bone and the component being inserted into the bone and (2) allows for bony ingrowth to prevent dislodging of the compression screw 10. The cutting flutes 36 act to remove bone and guide said removed bone into the slots 38. This is in effect a self-grafting feature of the compression sleeve 30 which enhances purchase. Surgeons will sometimes remove bone and pack it back into the implant to enhance purchase, however, this configuration on the compression sleeve 30 does that for them. Enhanced purchase acts to prevent screw toggle and screw axial motion. Even if the slots 38 are not filled with bone, they can act to prevent both screw toggle and screw axial motion by providing a surface to catch on the native bone. Additionally, the slots 38 provide a surface for bony ingrowth which can also prevent screw toggle and screw axial motion.

**[0030]** While the trajectory of the slots 38 is shown in the embodiment of Figs. 3 and 4 to roughly follow the pitch of the cutting flutes 36, the slots may have other configurations. For example, in the compression sleeve 30" illustrated in Fig. 5, the slot 38' has a steeper trajectory than the pitch of the cutting flutes. Fig. 6 illustrates another embodiment of the compression sleeve 30"" wherein the slot 38"" has an even steeper trajectory, being substantially parallel to the axis of the compression sleeve 30"". In addition to having different trajectories, the slots 38, 38', 38"" may have different pitches resulting

in the slots being spaced closer together or further apart. Additionally, the slots 38, 38', 38" may have different configurations, for example, semi-circular, semi-oval, v-shaped, square, rectangular or the like. Furthermore, while the combination of cutting flutes 36 and slots 38, 38', 38" are illustrated in conjunction with the compression sleeve 30, it is recognized that such can be applied to a surface of any type of component that is being inserted into bone.

**[0031]** Having generally described the compression screw 10, an exemplary driver assembly 100 for inserting the compression screw 10 and an exemplary method of insertion will be described with reference to Figs. 7 and 8.

**[0032]** The driver assembly 100 has a bone screw driver 110 and a compression sleeve driver 120. The bone screw driver 110 includes a driver shaft 112 extending from a distal end 111 to a proximal end 113. A driver tip 114 is defined on the distal end 111 of the driver shaft 112 and is configured to engage the driver feature 22 of the bone screw 12. A connection key 115 is defined on the proximal end 113 of the driver shaft 112 and is configured to facilitate connection of the bone screw driver 110 to a manual or powered rotation device or a locking device which prevents rotation (not shown). A series of axial splines 116 extend radially from the driver shaft 112 and are configured to be selectively engaged by a connector switch 128 of the compression sleeve driver 120, as will be described in more detail hereinafter. A series of external threads 119 extend from the driver shaft 112 distally of the splines 116. The external threads 119 are configured to be selectively engaged by a thread engagement member 132 of the compression sleeve driver 120, as will be described in more detail hereinafter.

**[0033]** The compression sleeve driver 120 extends from a distal end 121 to a proximal end 123. The proximal end 121 is defined by a tubular body 125 with a driver tip 124 at the distal most end and an outward housing 130 proximally therefrom. The driver tip 124 is configured to engage the driver feature 42 of the compression sleeve 30. The housing 130 defines a radial chamber in which the thread engagement member 132 is radially moveable. Upon depression of the thread engagement member 132, internal threads thereof engage the external threads 119 of the driver shaft 112 such that the driver shaft 112 is caused to move axially with the compression sleeve driver 120 when they are rotated together as will be described.

**[0034]** A handle member 126 extends proximally from the housing 130 to the proximal end 123. The connector switch 128 extends transversely through the handle member 126 and is moveable between a non-engaged position (see Fig. 8) and an engaged position (see Fig. 13). In the non-engaged position, an open area 129 of the connector switch 128 aligns with the splines 116 such that the switch 128 is not engaged with the splines 116 and the compression sleeve driver 120 rotates independent of the bone screw driver 110. In the engaged position, a contact portion 127 of the connector switch 128 engag-

es the splines 116 such that rotation of the compression sleeve driver 120 causes simultaneous rotation of the bone screw driver 110.

**[0035]** To insert the compression screw 10, the driver assembly 100 is positioned such that the driver tip 114 of the shaft 112 engages with the drive feature 22 of the bone screw 12 and the driver tip 124 of the tubular body 125 engages with the drive feature 42 of the compression sleeve 30, as shown in Fig. 8. During initial insertion, the connector switch 128 is moved to the engaged position such that the bone screw driver 110 and the compression sleeve driver 120 rotate together. The driver assembly 100 is rotated with both drivers 110, 120 rotating and thus the compression screw 10 is advanced as a single unit until the distal end 11 of the bone screw 12 is at a desired location. The thread engagement member 132 may be depressed during such rotation to ensure that the shaft 112 advances axially during the simultaneous rotation. If the distal end 31 of the compression sleeve 30 contacts bone as the compression screw 10 is advanced, the proximal rotary cutting structure, i.e. the cutting flutes 36, cut into the bone and the compression screw 10 is free to continue to advance as a single unit.

**[0036]** After the distal end 11 of the bone screw 12 has landed at the desired location, compression may be achieved by advancing the compression sleeve 30 while the bone screw 12 remains stationary. The bone screw 12 remains stationary by holding the bone screw driver 110 stationary, for example, by attaching a locking device to the connection key 115, and by disengaging the connector switch 128. With the connector switch 128 moved to the disengaged position, the compression sleeve driver 120 rotates freely about the bone screw driver 110. Rotation of the compression sleeve driver 120 causes the compression sleeve 30 to advance. Since the bone screw 12 is stationary as the compression sleeve driver 120 advances the compression sleeve 30, the compression screw 10 shortens in length and the shoulder 35 thus applies compression. Again, the cutting flutes 36 on the compression sleeve distal end 31 allow the compression sleeve 30 to cut into and advance into the bone.

**[0037]** Referring to Figs. 9-10, a compression screw 10' in accordance with another exemplary embodiment will be described. The compression screw 10' is substantially the same as the previous embodiment except with the addition of a self-countersinking head 34' on the compression sleeve 30<sup>iv</sup>. The self-countersinking head 34' has a tapered shoulder 35' and a series of external threads 37. The threads 37 are configured to be self-drilling and self-tapping. The self-countersinking head 34' is advantageous in that the head does not protrude from the near cortex, which minimizes soft-tissue irritation and can reduce the reoperation rate. In the present embodiment, the cutting flutes 36 and the threads 37 each define a proximal rotary cutting structure. In all other aspects, the compression screw 10' is the same as the previously described compression screw 10.

**[0038]** Referring to Figs. 11-13, a driver assembly 100'

and method for inserting the compression screw 10' will be described. The driver assembly 100' is substantially the same as in the previous embodiment except for the distal end 121' of tubular body 125' of the compression sleeve driver 120'. Instead of a driver tip, the distal end 121' defines an internally threaded chamber 122 which threadably engages the threads 137 of the self-countersinking head 34'.

**[0039]** To insert the compression screw 10', the driver assembly 100' is positioned such that the driver tip 114 of the shaft 112 engages with the drive feature 22 of the bone screw 12 and the threads 137 of the self-countersinking head 34' are threadably received in the threaded chamber 122 of the compression sleeve driver 120', as shown in Fig. 13. During initial insertion, the connector switch 128 is moved to the engaged position such that the bone screw driver 110 and the compression sleeve driver 120' rotate together. The driver assembly 100' is rotated with both drivers 110, 120' rotating and thus the compression screw 10' is advanced as a single unit until the distal end 11 of the bone screw 12 is at a desired location. The thread engagement member 132 may be depressed during such rotation to ensure that the shaft 112 advances axially during the simultaneous rotation. If the distal end 31 of the compression sleeve 30<sup>iv</sup> contacts bone as the compression screw 10' is advanced, the cutting flutes 36 cut into the bone and the compression screw 10' is free to continue to advance as a single unit.

**[0040]** After the distal end 11 of the bone screw 12 has landed at the desired location, compression may be achieved by advancing the compression sleeve 30<sup>iv</sup> while the bone screw 12 remains stationary. The bone screw 12 remains stationary by holding the bone screw driver 110 stationary, for example, by attaching a locking device to the connection key 115, and by disengaging the connector switch 128. With the connector switch 128 moved to the disengaged position, the compression sleeve driver 120' rotates freely about the bone screw driver 110. Rotation of the compression sleeve driver 120' causes the compression sleeve 30<sup>iv</sup> to advance. Since the bone screw 12 is stationary as the compression sleeve driver 120' advances the compression sleeve 30<sup>iv</sup>, the compression screw 10' shortens in length and the shoulder 35' and distal end 121' of the compression sleeve driver 120' thus apply compression. Again, the cutting flutes 36 on the compression sleeve distal end 31 allow the compression sleeve 30 to cut into and advance into the bone.

**[0041]** After the desired amount of compression has been reached, the head 34' may be countersunk. Countersinking is done by a third driver component (not shown) that mates with the compression sleeve driver feature 42. For example, the driver assembly 100 may be exchanged for the driver assembly 100' such that the driver tip 124 can be used to rotate the compression sleeve 30<sup>iv</sup> while the bone screw 12 is maintained stationary. As the compression sleeve 30<sup>iv</sup> advances over the bone screw

12, the threads 37 cut into the bone and advance the head 34' into a countersunk position within the bone.

**[0042]** Referring to Figs. 14-16, a compression screw 50 in accordance with another embodiment will be described. The compression screw 50 includes a shaft 52 extending from a distal end 51 to a proximal end 53. A series of bone engaging threads 55 extend radially from the shaft 52 at the distal end 51. In the preferred embodiment, the bone engaging threads 55 are dual lead thread type, however, any type of thread may be used to facilitate the function of the compression screw 50. The distal end 51 preferably also includes at least one cutting flute 56 configured to cut into the bone as the compression screw 12 is rotated, defining a self-drilling and self-tapping tip. In a preferred embodiment, a slot 57 is associated with each cutting flute 56 to clear any chips, dust, or debris generated when the compression screw 50 is implanted into bone tissue.

**[0043]** The proximal end 53 of the shaft 52 includes a self-countersinking head 54. The self-countersinking head 54 has a tapered shoulder 68 and a series of external threads 64. The threads 64 may include one or more cutting flutes 66 such that the threads 64 are self-drilling and self-tapping. In the present embodiment, the threads 64 define a proximal rotary cutting structure. A drive feature 62 is defined in the proximal end 53 of the shaft 52 and is configured and dimensioned to be any shape that corresponds with the end of the driving instrument designed to engage the compression screw 50. As an example, in the illustrated embodiment, the drive feature 62 has a hexalobular configuration.

**[0044]** The shaft 52 between the bone engaging threads 55 and the head 54 is preferably free of threads. With this configuration, a difference in pitch between the bone engaging threads 55 and the threads 64 of the head 54 can provide additional compression control as the compression screw 50 is inserted. That is, if the pitch of the bone engaging threads 55 is larger than the pitch of the threads 64 of the head 54, and the fracture or joint line lies somewhere in the shaft 52 section of the screw 50, this configuration will provide compression between the two bones as the distal end 51 tries to advance faster than the head 54 of the screw 50.

**[0045]** Referring to Figs. 17 and 18, a driver assembly 150 which allows the surgeon to further control how much compression is achieved will be described. The driver assembly 150 includes an inner driver member 152 and an outer driver member 160. The inner driver member 152 extends from a distal end 151 to a proximal end 153. A driver tip 154 is defined on the distal end 151 and is configured to engage the driver feature 62 of the compression screw 50.

**[0046]** The outer driver member 160 includes a tubular body extending from a distal end 161 to a proximal end 163. The distal end 161 defines a threaded chamber 164 configured to threadably receive the threads 64 of the compression screw head 54.

**[0047]** To insert the compression screw 50, the driver

assembly 50 is positioned with the driver tip 154 engaged with the driver feature 62 and the threads 64 of the head 54 threadably received in the threaded chamber 164. The inner and outer driver members 152, 160 are rotated such that the compression screw 50 is advanced. As the compression screw 50 advances, the distal end 161 of the outer driver member 160 will hit the near cortex and compress the fracture line as the screw 50 is continued to be inserted.

**[0048]** After the desired amount of compression has been reached, the inner driver member 152 is rotated, independent of the outer driver member 160, such that the compression screw 50 continues to advance with the outer driver member distal end 161 maintaining the compression. As the compression screw 50 advances, the threads 64 of the head 54 will enter the bone and begin to countersink the head 54. As the head 54 advances and countersinks, it simultaneously threads out of the threaded chamber 164. As explained before, the pitch of the bone engaging threads 55 and the threads 64 of the head 54 may be configured such that countersinking of the head 54 causes additional compression.

**[0049]** These and other advantages of the present invention will be apparent to those skilled in the art from the foregoing specification. Accordingly, it will be recognized by those skilled in the art that changes or modifications may be made to the above-described embodiments without departing from the broad inventive concepts of the invention. It should therefore be understood that this invention is not limited to the particular embodiments described herein, but is intended to include all changes and modifications that are within the scope and spirit of the invention as defined in the claims.

The invention

**[0050]** The invention could be inter alia defined by the following aspects.

1. A compression screw for applying compression at a bone joint, the compression screw comprising: an axial screw body extending from a distal end to a proximal end, the distal end including a series of bone engaging threads configured to be self-drilling and self-tapping, and the proximal end including a head which defines a radially extending shoulder, wherein at least one proximal rotary cutting structure is defined proximally of the bone engaging threads, the at least one proximal rotary cutting structure configured to be self-drilling such that a proximal portion of the axial screw body cuts into and advances within a bone of the bone joint as the axial screw body is advanced.
2. The compression screw according to aspect 1 wherein the at least one proximal rotary cutting structure is defined by a series of external threads on the head such that the head is self-countersinking.
- aspect 3. The compression screw according to as-

pect 2 wherein the axial screw body is defined by a shaft and the shaft is free of threads between the bone engaging threads and the head.

4. The compression screw according to aspect 3 wherein the pitch of the bone engaging threads is larger than the pitch of the external threads on the head.

5. The compression screw according to aspect 1 wherein the radially extending shoulder has a tapered configuration.

6. The compression screw according to aspect 1 wherein the axial screw body is defined by a bone screw and a compression sleeve, the bone screw extending from a bone screw distal end to a bone screw proximal end, the bone screw distal end defining the axial screw body distal end including the series of bone engaging threads, and the bone screw proximal end including a series of external threads; the compression sleeve having a tubular body extending from a compression body distal end to a compression body proximal end, the compression sleeve proximal end defining the axial screw body proximal end including the head, the compression sleeve distal end defining at least one of the proximal rotary cutting structures and, the compression sleeve including internal threads engaged with the bone screw external threads such that the compression sleeve and bone screw are threadably adjustable relative to one another.

7. The compression screw according to aspect 6 wherein the at least one proximal rotary cutting structures is defined by a plurality of cutting flutes defined at the compression sleeve distal end.

8. The compression screw according to aspect 7 wherein each cutting flute has a slot extending therefrom, each slot recessed into the tubular body.

9. The compression screw according to aspect 6 wherein the bone screw proximal end and the compression sleeve proximal end each define a distinct driver feature.

10. The compression screw according to aspect 6 wherein the head includes external threads such that the head is self-countersinking, the external threads on the head defining a second proximal rotary cutting structure.

11. A compression screw for applying compression at a bone joint, the compression screw comprising: a bone screw extending from a distal end to a proximal end, the bone screw distal end including a series of bone engaging threads configured to be self-drilling and self-tapping, and the bone screw proximal end including a series of external threads; a compression sleeve having a tubular body extending from a distal end to a proximal end, the compression sleeve distal end defining a proximal rotary cutting structure and the compression sleeve proximal end including a head which defines a radially extending shoulder, the compression sleeve including internal

threads engaged with the bone screw external threads such that the compression sleeve and bone screw are threadably adjustable relative to one another; wherein the proximal rotary cutting structure is configured to be self-drilling such that a portion of the compression sleeve cuts into and advances within a bone of the bone joint as the compression screw is advanced.

12. The compression screw according to aspect 11 wherein the bone screw proximal end and the compression sleeve proximal end each define a distinct driver feature.

13. The compression screw according to aspect 11 wherein the head includes external threads such that the head is self-countersinking, the external threads on the head defining a second proximal rotary cutting structure.

14. The compression screw according to aspect 11 wherein the at least one proximal rotary cutting structures is defined by a plurality of cutting flutes defined at the compression sleeve distal end.

15. The compression screw according to aspect 14 wherein each cutting flute has a slot extending therefrom, each slot recessed into the tubular body.

16. The compression screw according to aspect 15 wherein the cutting flutes have a trajectory and each slot has a trajectory substantially equal to the trajectory of the cutting flutes.

17. The compression screw according to aspect 15 wherein the cutting flutes have a trajectory and each slot has a trajectory greater than the trajectory of the cutting flutes.

18. The compression screw according to aspect 15 wherein each slot has a trajectory substantially parallel to an axis of the compression sleeve.

19. The compression screw according to aspect 15 wherein each slot has a cross-sectional configuration selected from semi-circular, semi-oval, v-shaped, square and rectangular.

20. A method of inserting a compression screw into a bone joint, the method comprising: engaging the compression screw with a driver assembly, the driver assembly including a first driver and a second driver, the first and second drivers co-axial with one another and selectively rotatable together or independently of one another; rotating the first and second drivers simultaneously to advance the compression screw into the bone joint until the compression screw is at a first desired location; and rotating the first driver while maintaining the second driver stationary whereby at least a portion of the compression screw is further advanced into the bone joint such that a compressive force is applied to the bone joint.

## Claims

1. A compression screw for applying compression at a

bone joint, the compression screw comprising:

- an axial screw body extending from a distal end to a proximal end, the distal end including a series of bone engaging threads configured to be self-drilling and self-tapping, and the proximal end including a head which defines a radially extending shoulder,
- wherein at least one proximal rotary cutting structure is defined proximally of the bone engaging threads, the at least one proximal rotary cutting structure configured to be self-drilling such that a proximal portion of the axial screw body cuts into and advances within a bone of the bone joint as the axial screw body is advanced.

2. The compression screw according to claim 1 wherein the at least one proximal rotary cutting structure is defined by a series of external threads on the head such that the head is self-countersinking.

3. The compression screw according to claim 2 wherein the axial screw body is defined by a shaft and the shaft is free of threads between the bone engaging threads and the head.

4. The compression screw according to claim 3 wherein the pitch of the bone engaging threads is larger than the pitch of the external threads on the head.

5. The compression screw according to claim 1 wherein the radially extending shoulder has a tapered configuration.

6. The compression screw according to claim 1 wherein the axial screw body is defined by a bone screw and a compression sleeve, the bone screw extending from a bone screw distal end to a bone screw proximal end, the bone screw distal end defining the axial screw body distal end including the series of bone engaging threads, and the bone screw proximal end including a series of external threads;

- the compression sleeve having a tubular body extending from a compression body distal end to a compression body proximal end, the compression sleeve proximal end defining the axial screw body proximal end including the head, the compression sleeve distal end defining at least one of the proximal rotary cutting structures and, the compression sleeve including internal threads engaged with the bone screw external threads such that the compression sleeve and bone screw are threadably adjustable relative to one another.

7. The compression screw according to claim 6 wherein

the at least one proximal rotary cutting structures is defined by a plurality of cutting flutes defined at the compression sleeve distal end.

8. The compression screw according to claim 7 wherein each cutting flute has a slot extending therefrom, each slot recessed into the tubular body. 5
9. The compression screw according to claim 6 wherein the bone screw proximal end and the compression sleeve proximal end each define a distinct driver feature. 10
10. The compression screw according to claim 6 wherein the head includes external threads such that the head is self-countersinking, the external threads on the head defining a second proximal rotary cutting structure. 15

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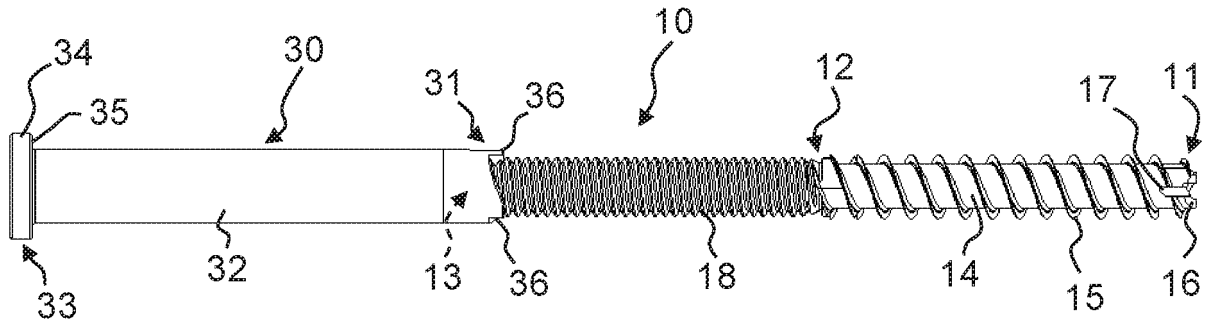


Fig. 1

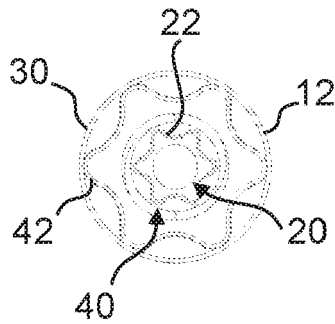


Fig. 2

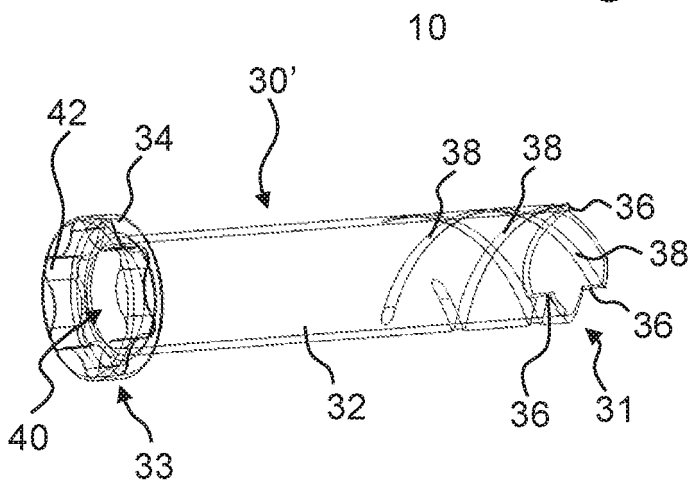


Fig. 3

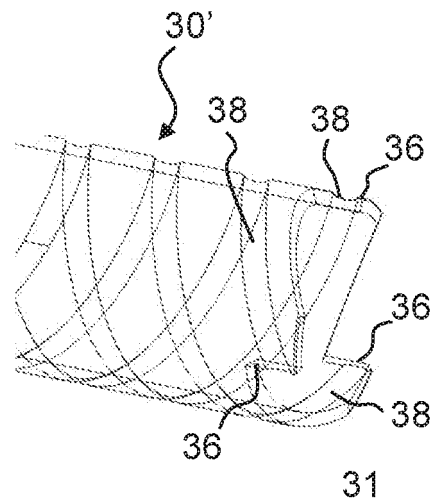


Fig. 4

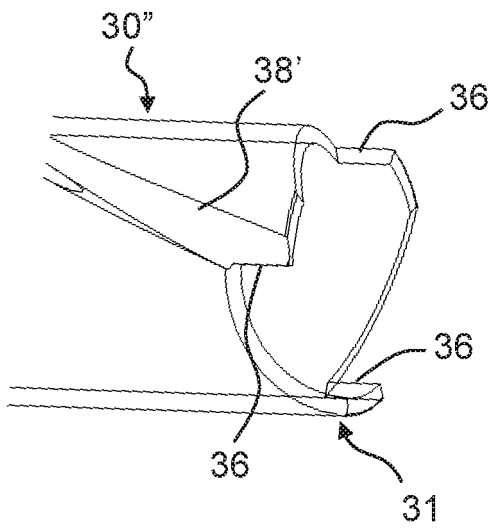


Fig. 5

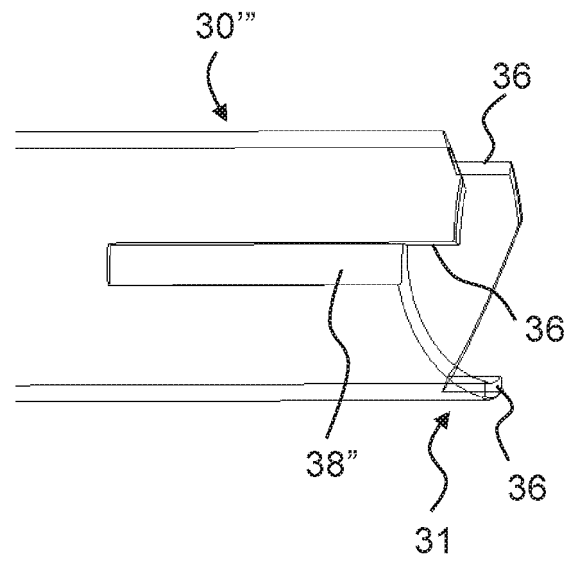


Fig. 6

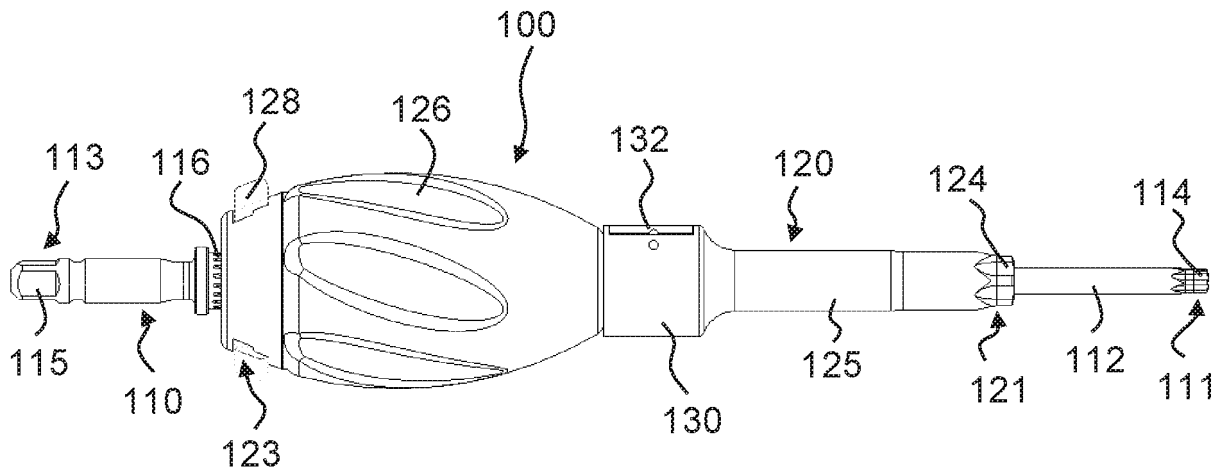


Fig. 7

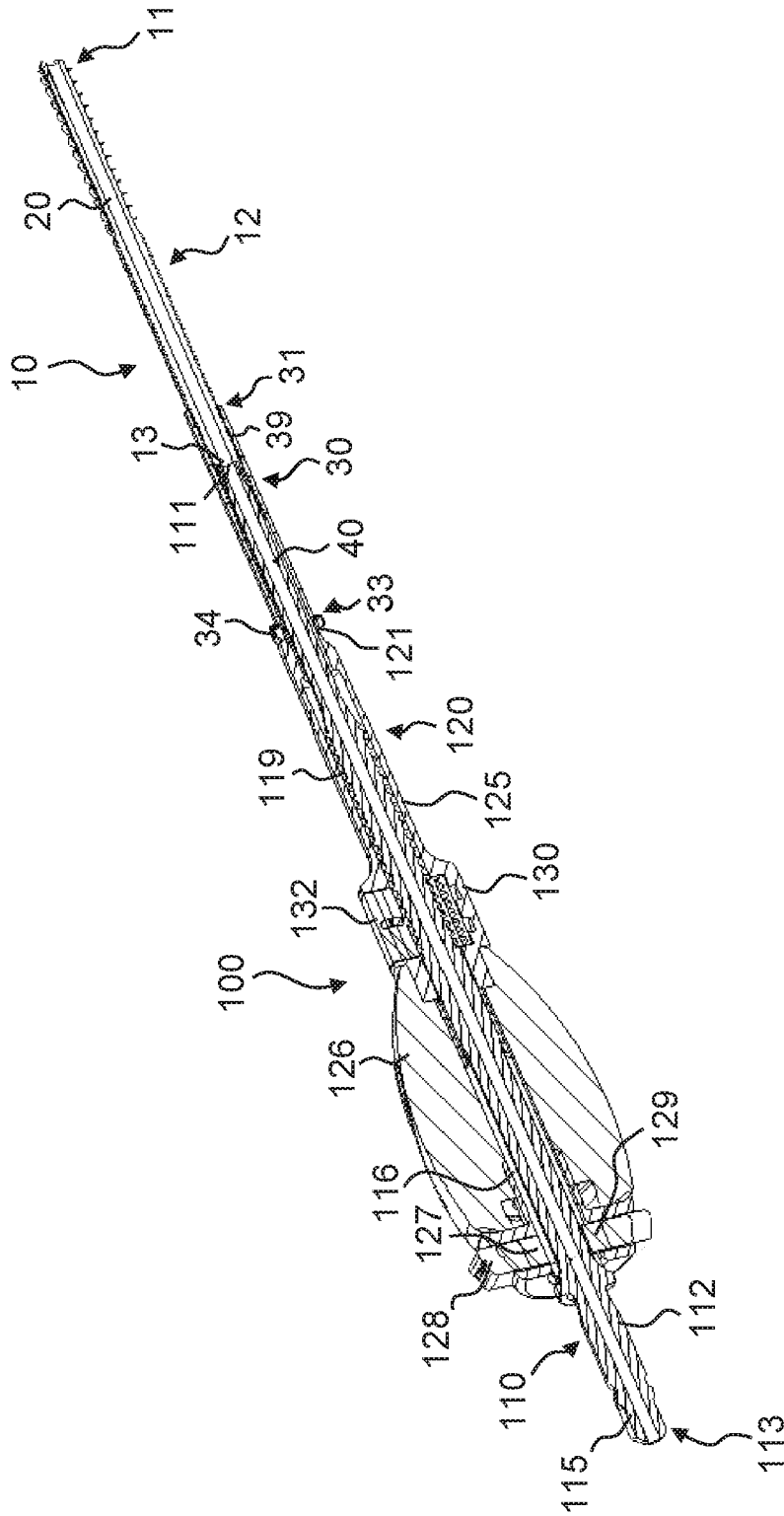


Fig. 8

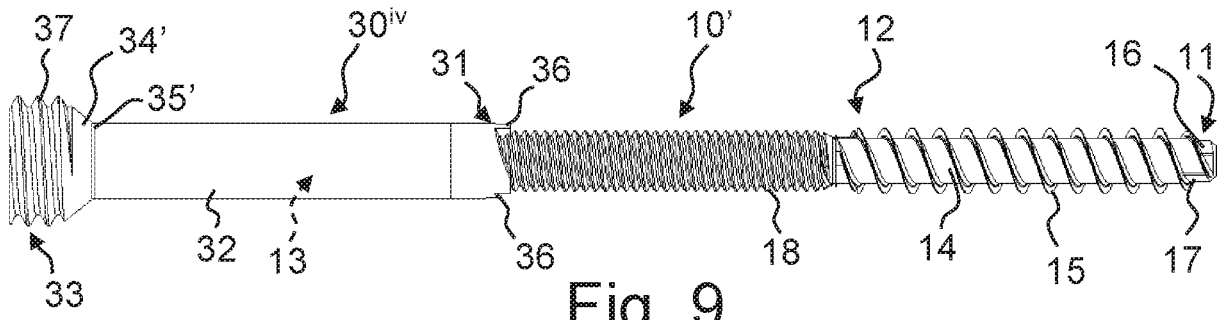


Fig. 9

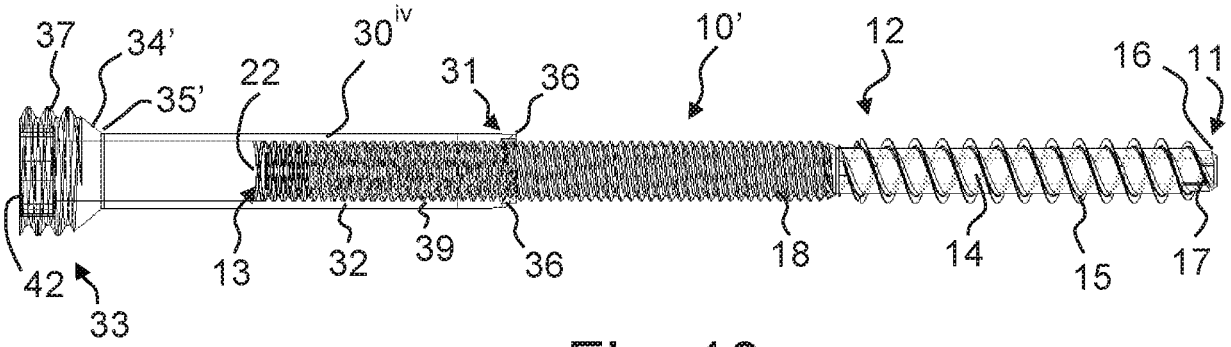


Fig. 10

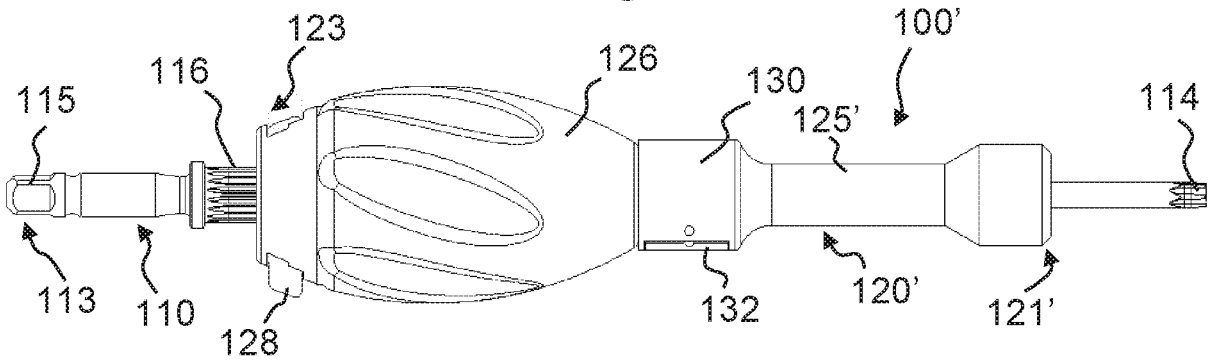


Fig. 11

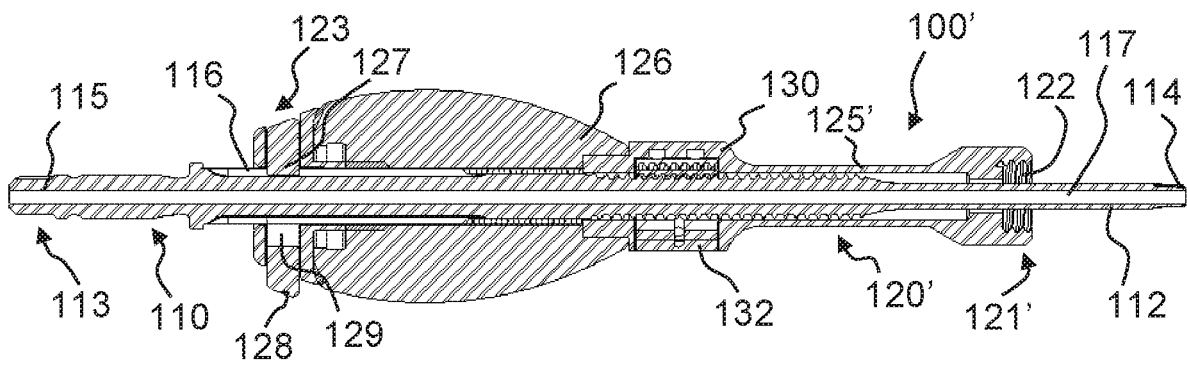


Fig. 12

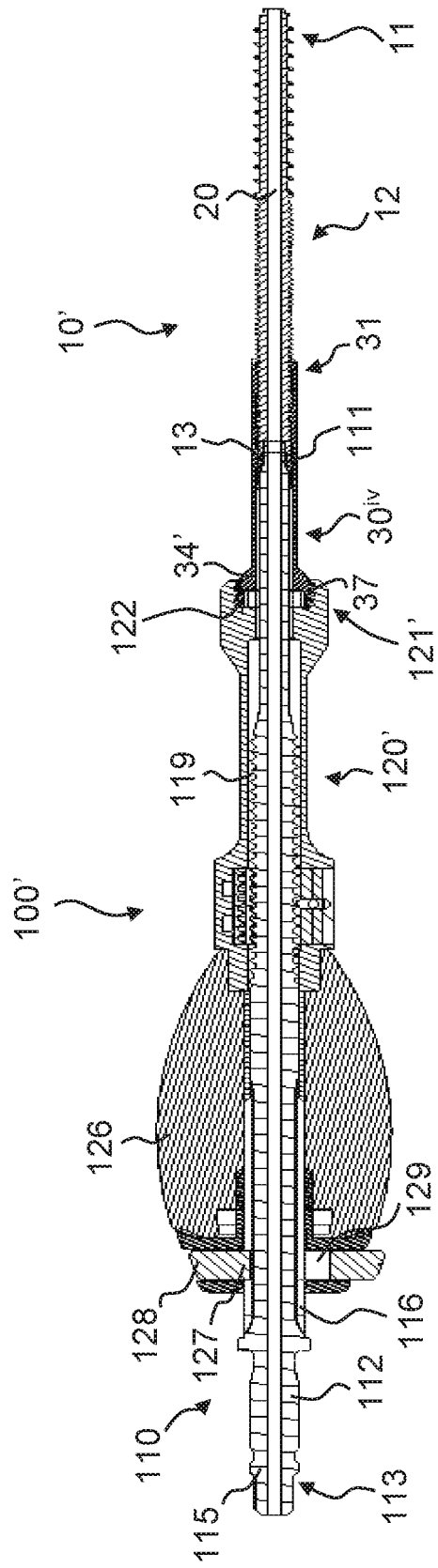


Fig. 13

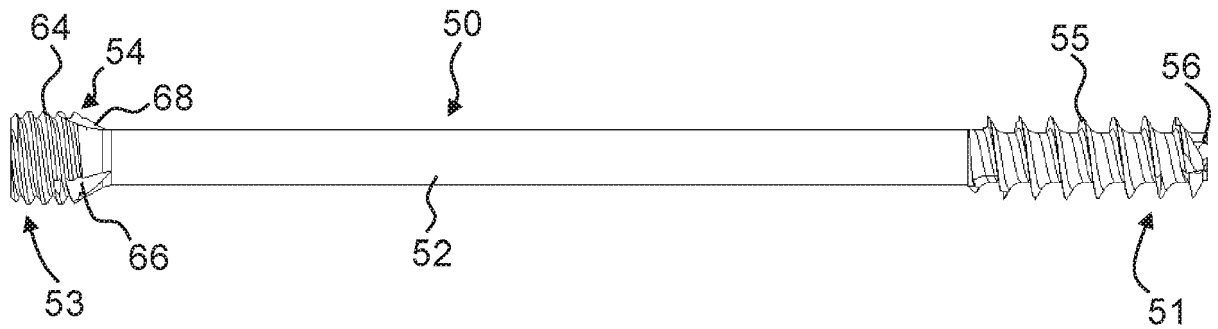


Fig. 14

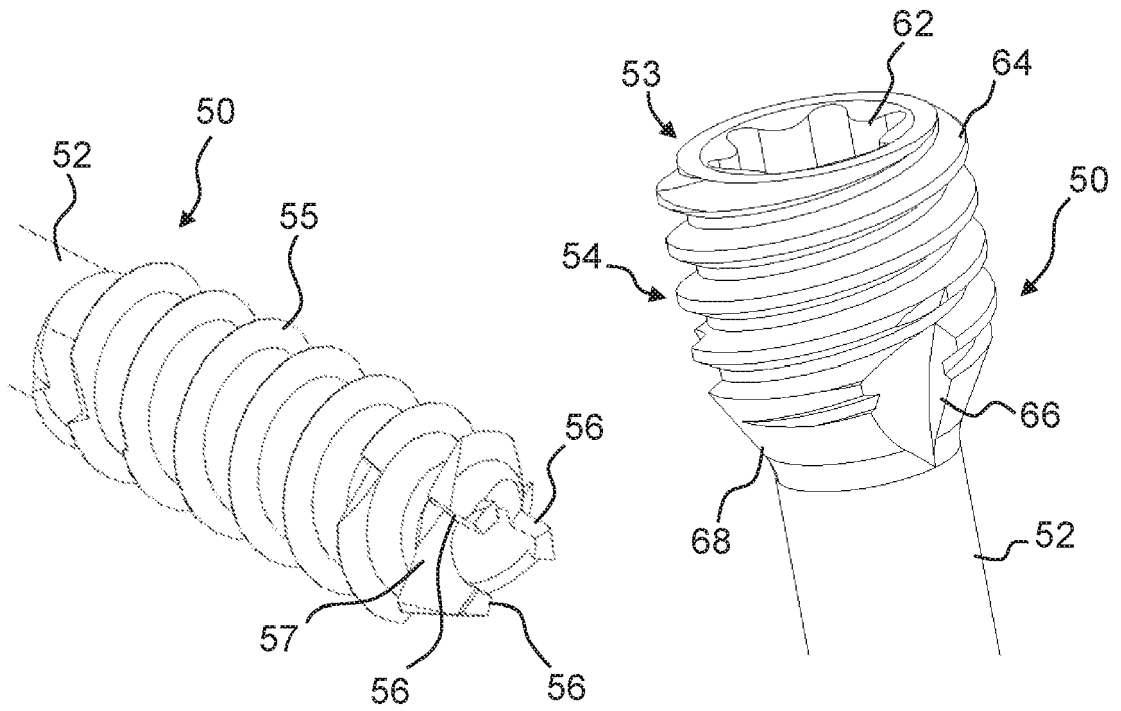


Fig. 15

Fig. 16

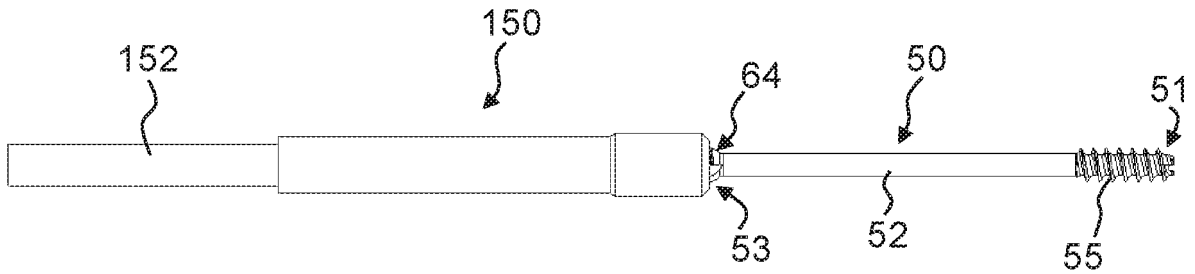


Fig. 17

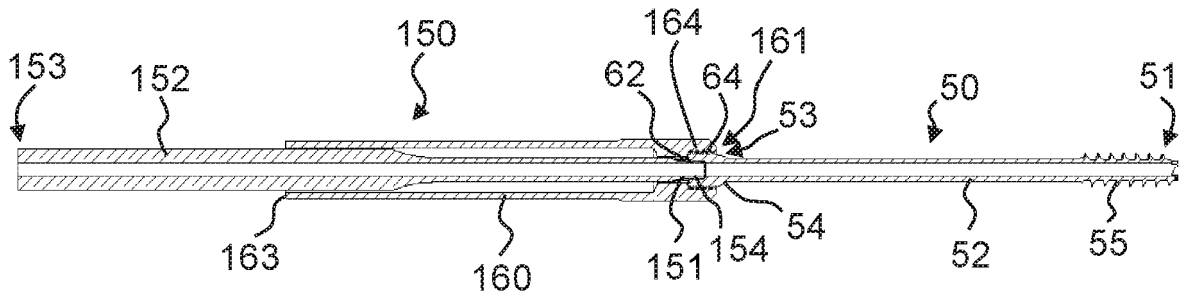


Fig. 18



EUROPEAN SEARCH REPORT

Application Number  
EP 17 16 6775

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X	US 5 743 912 A (LAHILLE MICHEL [FR] ET AL) 28 April 1998 (1998-04-28) * figure 8 *	1-10	
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Place of search Munich		Date of completion of the search 27 June 2017	Examiner Fernández Arillo, J
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27-06-2017

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